

Flame Propagation in a Dump Combustor with Shear Layer Excitation



Completed Technology Project (2014 - 2015)

Project Introduction

This experimentation looks to investigate the use of fluidic oscillators to attenuate combustion instability in a naturally unstable rocket combustor. Since combustion instability is a major cost driver in new combustion devices including rockets, aircraft engines, and gas turbines for power generation, this application has the potential for major cost savings in terms of development time and testing. As rocket engine reusability becomes an important issue with commercial space enterprises, fluidic oscillator controlled combustion could reduce existing engine instabilities thereby enhancing combustor life and reducing life-cycle costs. Fluidic oscillators use internal fluid dynamic interactions to generate oscillating jets over a wide range of frequencies and can reach up to 20 kHz. Since the fluidic oscillators require no moving parts or power to operate, they offer a much more feasible solution to active control of combustion instability in terms of integration into current designs and reliability. Previous studies have found instability attenuation of up to 40% in a natural gas and atmospheric air combustor, however no data exists for high pressure, high temperatures, and high frequency environments seen in rocket combustors. The first step will involve computational fluid dynamics (CFD) analysis to optimize the fluidic oscillator designs for specific frequencies and flow rates. Additive manufacturing such as direct metal laser sintering (DMLS) will allow for rapid and cost effective manufacturing of fluidic oscillator manifolds to be mounted to a naturally unstable rocket combustor already in place at Purdue University. Experimentation using high frequency pressure transducers and high speed imagery of the combustion process will measure the reduction or amplification of the combustion instability for known injection frequencies from the fluidic oscillators. Conclusions will draw upon the effectiveness of fluidic oscillators at reducing combustion instability, feasibility for integration into real world combustion devices, and recommendations for design considerations. NASA expertise will assist in design and packaging of the fluidic oscillator manifold as well as achieving a design with the potential for integration into existing rocket engines.

Anticipated Benefits

Since combustion instability is a major cost driver in new combustion devices including rockets, aircraft engines, and gas turbines for power generation, this application has the potential for major cost savings in terms of development time and testing. As rocket engine reusability becomes an important issue with commercial space enterprises, fluidic oscillator controlled combustion could reduce existing engine instabilities thereby enhancing combustor life and reducing life-cycle costs.



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Organizational Responsibility

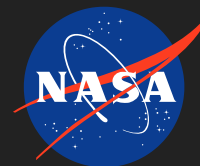
Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

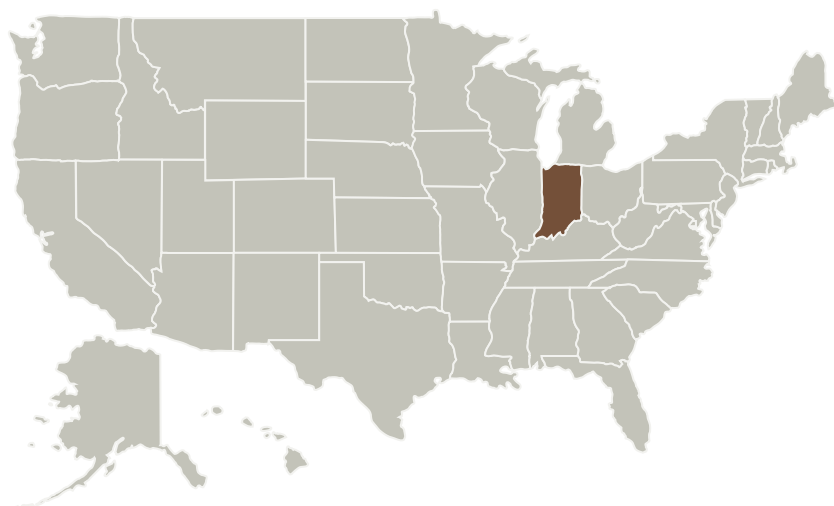
Space Technology Research Grants

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Purdue University-Main Campus	Supporting Organization	Academia	West Lafayette, Indiana

Primary U.S. Work Locations

Indiana

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

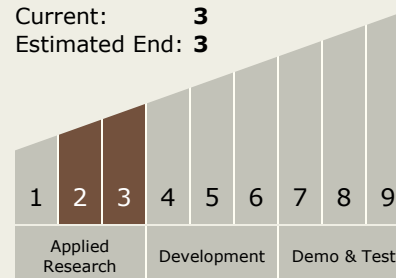
Stephen D Heister

Co-Investigator:

Eric J Meier

Technology Maturity (TRL)

Start: 2
 Current: 3
 Estimated End: 3



Technology Areas

Primary:

- TX01 Propulsion Systems
 - TX01.3 Aero Propulsion
 - TX01.3.4 Pressure Gain Combustion